New advances and progress in stimulated luminescence dating

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Several human's milestones were directly linked to ages up to 4 Ma ago. Consequently, there is an increased interest for archaeologists, geologists and researchers of various specialties in multidisciplinary dating of all these aforementioned milestones of human history, using a robust and reliable technique. The aim of my speech is describing the potential of stimulated luminescence dating techniques within this perspective. Having presented the basic theory, the physical concept and the rationale of the technique, special emphasis was given to the samples that could be dated using luminescence dating, as these can be divided into two groups. The first group includes archaeological samples that were heated in the past such as ceramics, pottery, porcelain, bricks, flints, kilns and in general fired or even burnt materials, along with solidified lava and siliceous rocks (cherts); in that group, heating is the zeroing mechanism, and thus luminescence can date the last heating event. The second group includes geological sediments whose grains have been exposed to sunlight during transport or deposition and also includes cultural deposits and archaeological artefacts that could be dated using surface exposure dating, such as masonry, megalithic buildings and constructions, monolithic structures and monuments along with rock art and mortars. The optically stimulated luminescence (OSL) technique works exclusively for those sediments that were exposed to the most daylight during transportation, including wind-blown sands and silts. Nevertheless, in general OSL dating is suitable for a wide range of sedimentary deposits such as soils, anthropogenic layers, fluvial deposits, lacustrine, lagoonal and marine deposits, sand-dune deposits and loess. A number of unconventional luminescence dating applications are presented, such as dating of graves and burials, sediment source, rock art, olive tree planting, portable paintings, re-crystallization of either salt or gypsum formations and slope wash sediments. In contrast, limitations in both sampling and handling are also highlighted. Unresolved challenges in stimulated luminescence dating include the limited number of minerals used for age assessment applications, the time-consuming preparation and handling procedure, the relatively large errors especially for the case of young ceramics and of course the age thresholds/limits. Thermoluminescence (TL) covers the entire range of the historical periods related to pottery, up to about 50.000 years (50 ka), while for the cases of geological materials ages up to 250 ka have been reported. On the other hand, despite the adequate thermal stability of the OSL signal for dating back to a million years, experimental ages determined in the laboratory are well below this upper limit. Conventional OSL age limits are extended up to 350 ka although, occasionally higher ages, up to 600 - 700 ka have also been reported. Specific protocols of infrared stimulated luminescence (IRSL) indicated ages with maximum limit of 1Ma and 15-20% corresponding relative errors. From a theoretical point of view, stimulated luminescence is expected to provide absolute ages up to 1 Ma and beyond. Among the several ways to deal with the problem of luminescence age limit extension, specific new methods of stimulating luminescence were presented in detail, such as thermally assisted optically stimulated luminescence (TA – OSL) and infrared photoluminescence (IRPL). The advanced technology in electronics and solid-state physics has enabled the development of more sophisticated instrumentation and capabilities, providing thus the possibility to use optical fibers, CCD cameras, remote operation and cryogenics, as well as to stimulate single individual grains. New computational technologies, such as the analysis using Bayesian statistics and machine learning algorithms will help further the interpretation of results not only in geoarchaeological dating, but in other luminescence applications as well, such as authenticity testing, forgery identification,, archaeothermo(chrono)metry and studies of meteorites.